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HONEYCOMB CONFIGURATION BODY

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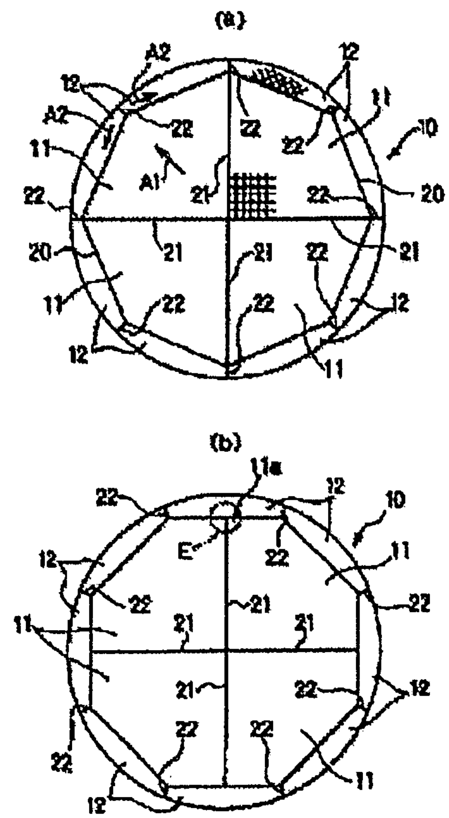
Abstract of **JP7286797**

PURPOSE:To contrive to elongate a life time, by preventing a breakage caused by a thermal stress, with an ensurance of a sufficient flow path area with respect to a honeycomb composition body. CONSTITUTION:A honeycomb composition body arranged in an inside of a cylindrical state material forming a high temperature fluid path is divided, with respect to a diameter direction, to a central section segment 11 and an outside shell section segment 12. A total summation of a flow path area of the outside section flow path area, that is to say, of the outside shell section segment 12 is made to be 50% and less with respect to a total summation of a flow path area of all of the honeycomb composition body 10, that is to say, a flow path area of all segment 11, 12.



CLAIMS

[Claim(s)]

[Claim 1]In a honeycomb structured body allotted to direction from which the passage direction and above-mentioned through hole become with abbreviated parallel inside a cylindrical member which has a through hole of parallel a large number mutually, and forms a channel of a high-temperature fluid, While dividing this honeycomb structured body into a center section and an outer shell part which surround the circumference of this center section about a diameter direction of the above-mentioned cylindrical member and dividing the above-mentioned outer shell part into a hoop direction, A honeycomb structured body setting up shape of the above-mentioned center section and an outer shell part so that a flow area of this outer shell part may turn into 50% or less of flow areas of the whole honeycomb structured body.

[Claim 2]A honeycomb structured body setting up shape of the above-mentioned center section and an outer shell part in the honeycomb structured body according to claim 1 so that a flow area of the above-mentioned outer shell part may turn into 30% or less of flow areas of the whole honeycomb structured body.

[Claim 3]A honeycomb structured body making a hoop direction position of a parting plane of this center section agree in the honeycomb structured body according to claim 1 or 2 in a hoop direction position of a parting plane of the above-mentioned outer shell part while only a number below the number of partitions of the above-mentioned outer shell part divides the above-mentioned center section into a hoop direction.

[Claim 4]A honeycomb structured body having made the above-mentioned center section into polygonal shape with the peak of a number below the number of partitions of the above-mentioned outer shell part in the honeycomb structured body according to any one of claims 1 to 3, and making a hoop direction position of the peak of this center section, and a hoop direction position of a parting plane of the above-mentioned outer shell part agree.

[Claim 5]A honeycomb structured body dividing this honeycomb structured body into the above-mentioned center section, pars intermedia, and the above-mentioned outer shell part sequentially from the diameter direction inside in the honeycomb structured body according to any one of claims 1 to 4.
[Claim 6]While only a number below the number of partitions of the above-mentioned outer shell part divides the above-mentioned pars intermedia into a hoop direction and only a number below the number of partitions of the above-mentioned pars intermedia divides the above-mentioned center section into a hoop direction in the honeycomb structured body according to claim 5, A honeycomb structured body having made a hoop direction position of a parting plane of the above-mentioned pars intermedia agree in a hoop direction position of a parting plane of the above-mentioned outer shell part, and making a hoop direction position of a parting plane of the above-mentioned center section agree in a hoop direction position of a parting plane of the above-mentioned pars intermedia.
[Claim 7]A honeycomb structured body having made the above-mentioned center section into polygonal shape with the peak below the number of partitions of the above-mentioned pars intermedia in the honeycomb structured body according to claim 5 or 6, and making a hoop direction position of the peak of this center section, a hoop direction position of a parting plane of the above-mentioned pars intermedia, and a hoop direction position of a parting plane of an outer shell part agree.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to the honeycomb structured body used for the rectification means of the heat-regenerative element of the combustion catalyst for **NOx reduction, and ** heat energy or a radiator, and ** hot wind, etc.

[0002]

[Description of the Prior Art]Generally, the honeycomb structured body used for the above purpose is formed in honeycomb shape by cordierite, alumina, ceramics called SiC, etc. Inside the cylindrical member which forms the channel of a high-temperature fluid, it is allotted to the direction used as abbreviated parallel, and as the channel of this high-temperature fluid and many a honeycomb structured body's own through holes pour the above-mentioned high-temperature fluid to the above-mentioned through hole, they are used.

For example, to JP,5-231608,A. By making a cordierite honeycomb base support the precious metals, such as palladium and platinum, via coating materials, such as alumina, a tabular combustion catalyst body is constituted and the catalytic combustion apparatus for NOx reduction with which this combustion catalyst body has been arranged inside a cylindrical member is indicated.

[0003]By the way, in order to increase the amount of gassing in such a burner or to lower the draft resistance within the above-mentioned cylindrical member, it is effective to set up greatly the flow area of the above-mentioned honeycomb structured body, but. A limit is among the sizes which can carry out integral moulding of the whole honeycomb structured body naturally, maintaining the dimensional accuracy and intensity of a honeycomb good. Since it is difficult to make uniform a gas flow within the above-mentioned cylindrical member, it is hard to avoid the position temperature change on a honeycomb structured body flat surface, and there is inconvenience which a honeycomb structured body tends to damage by a thermal shock.

Since especially the honeycomb structured body made from ceramics has high brittleness, there is a possibility that a crack etc. may occur also in comparatively small stress.
[0004]Although it is possible to enlarge Young's modulus of material itself [of a honeycomb structured body], or to connect a small cylindrical member in parallel with a multi-mold as a means to cancel such inconvenience, In the case of the former, there is a limit in material refining naturally, and there is a fault which is easy to spoil the characteristic originally needed as a result of such refining. On the other hand, in the case of the latter, there is a fault which the whole device is enlarged and becomes complicated.
[0005]Then, conventionally, the above-mentioned honeycomb structured body is divided in the direction which intersects perpendicularly with the above-mentioned passage direction at two or more small segments (mutually almost equal segment of a flow area), and the art of obtaining the honeycomb structured body of a large area as a whole is proposed by finishing setting up these segments. For example, a honeycomb structured body is divided into a central circle configuration segment and the outside segment of plurality (for example, eight pieces) which surround this circle configuration segment, and that by which the radius of the above-mentioned circle configuration segment was set as the abbreviation half of the radius of the whole honeycomb structured body is shown in the above-mentioned gazette. Even if the whole of the rate of expansion is equal compared with the big honeycomb structured body by which integral moulding was carried out, the amount of absolute expansion of each segment decreases, and according to such a structure, it becomes difficult to produce the destruction resulting from the part and heat stress.
[0006]
[Problem(s) to be Solved by the Invention]Also in a honeycomb structured body as shown in the above-mentioned gazette, if long term use of this is carried out, It has become clear especially by the peripheral part (from a peripheral face to the inside [Specifically] a 5 mm - 20 mm-wide field, even if large field of 50 mm or less) that it is easy to produce a crack, and it is considered as the technical problem that the endurance to long-term use of such a honeycomb structured body is big.
[0007]An object of this invention is to provide the honeycomb structured body which can extend the life effectively, securing sufficient flow area in view of such a situation.
[0008]
[Means for Solving the Problem]Since a peripheral face of this honeycomb structured body touches a cylindrical member and radiates heat easily, as a result of this invention persons' examining the above honeycomb structured bodies, Temperature of a peripheral face is [state / where a high-temperature fluid is ventilated by honeycomb structured body / a center section of this honeycomb structured body] low, Conversely, in the state where a fluid for cooling is ventilated by honeycomb structured body, also when temperature of a peripheral

face became high and was any compared with the above-mentioned center section, a temperature gradient of a honeycomb structured body peripheral face immediately remarkable in an inside field occurred, and it traced that destruction by a thermal shock arose in a big field of this temperature gradient.

[0009]In a honeycomb structured body allotted to direction from which this invention is made as a result of such examination, and the passage direction and above-mentioned through hole become with abbreviated parallel inside a cylindrical member which has a through hole of parallel a large number mutually, and forms a channel of a high-temperature fluid, While dividing this honeycomb structured body into a center section and an outer shell part which surround the circumference of this center section about a diameter direction of the above-mentioned cylindrical member and dividing the above-mentioned outer shell part into a hoop direction, Shape of the above-mentioned center section and an outer shell part is set up so that a flow area of this outer shell part may turn into 50% or less (claim 2 30% or less) of flow areas of the whole honeycomb structured body (claim 1).

[0010]While only a number below the number of partitions of the above-mentioned outer shell part divides the above-mentioned center section into a hoop direction, this honeycomb structured body, Make a hoop direction position of a parting plane of the above-mentioned outer shell part agree, or a hoop direction position of a parting plane of this center section (Claim 3), The above-mentioned center section is made into polygonal shape with the peak of a number below the number of partitions of the above-mentioned outer shell part, and it will become still more desirable by what (claim 4) is made for a hoop direction position of the peak of this center section and a hoop direction position of a parting plane of the above-mentioned outer shell part to agree.

[0011]An effect like the after-mentioned which depended and was excellent is acquired by dividing this honeycomb structured body into the above-mentioned center section, pars intermedia, and the above-mentioned outer shell part sequentially from the diameter direction inside (claim 5).

[0012]While only a number below the number of partitions of the above-mentioned outer shell part divides the above-mentioned pars intermedia into a hoop direction and only a number below the number of partitions of the above-mentioned pars intermedia divides the above-mentioned center section into a hoop direction like a statement to claim 6 also in this case, Make a hoop direction position of a parting plane of the above-mentioned pars intermedia agree in a hoop direction position of a parting plane of the above-mentioned outer shell part, and a hoop direction position of a parting plane of the above-mentioned center section like a statement [**** / making a hoop direction position of a parting plane of the above-mentioned pars intermedia agree] to claim 7, A still more desirable thing is obtained by making the above-mentioned center section into polygonal shape with the peak below the number of

partitions of the above-mentioned pars intermedia, and making a hoop direction position of the peak of this center section, a hoop direction position of a parting plane of the above-mentioned pars intermedia, and a hoop direction position of a parting plane of an outer shell part agree.

[0013]

[Function]Since the above-mentioned outer shell part is divided into the hoop direction while being divided into the outer shell part which surround the circumference of a center section and this center section to the diameter direction of the above-mentioned cylindrical member, even if the above-mentioned center section expands on the diameter direction outside, big hoop direction tensile stress does not generate the honeycomb structured body according to claim 1 in an outer shell part. And since the flow area of this outer shell part is made into 50% or less of the flow areas of the whole honeycomb structured body, the parting plane of that part, a center section, and an outer shell part approaches a honeycomb structured body peripheral face conventionally. That is, in this honeycomb structured body, a honeycomb structured body will be divided into a diameter direction in a portion with the largest temperature gradient, or its neighborhood. Here the heat stress generated in a honeycomb structured body, Since it is what originates in the strain generated by the restraint of modification by a temperature change, and is generated, By dividing a honeycomb structured body into a center section and an outer shell part in the position near the big portion or this of a temperature gradient as mentioned above, the above-mentioned strain will be released, or the restraint will decrease, and the part heat stress is also reduced substantially.

[0014]In particular, in the honeycomb structured body according to claim 2, since the flow areas of the above-mentioned outer shell part are 30% or less of flow areas of the whole honeycomb structured body, the parting plane of a center section and an outer shell part will approach a peripheral face further, and heat stress is further reduced by this.

[0015]Since the above-mentioned center section is divided [the honeycomb structured body according to claim 3] into the hoop direction, even if the size which can carry out integral moulding of the honeycomb structured body has a limitation, it is possible to form a bigger center section by the above-mentioned division. And since the number of partitions of this center section was set as the number below the number of partitions of the above-mentioned outer shell part and the hoop direction position of the parting plane of this center section has agreed in the hoop direction position of the parting plane of the above-mentioned outer shell part, Even if the peak which originates in the size error of each segment (split piece) of a center section, etc., and touches the above-mentioned parting plane of this segment in the case of thermal expansion projects on the diameter direction outside, since the outer shell part is divided into the hoop direction in this projecting portion, each segment of an outer shell part can escape to a hoop direction. For this reason, there is no possibility that the vertex part of the segment of the above-mentioned center section may eat into an outer shell part, and big

stress may occur.
[0016]In the honeycomb structured body according to claim 4, since the above-mentioned center section is polygonal shape, the parting plane of this center section and outer shell part is a flat surface, and field doubling of these center sections and an outer shell part becomes easy that much. And since the hoop direction position of the peak of this center section and the hoop direction position of the parting plane of the above-mentioned outer shell part have agreed, Even if that vertex part projects on the diameter direction outside in the case of the thermal expansion of a center section, since the outer shell part is divided into the hoop direction in this projecting portion, each segment of an outer shell part can escape to a hoop direction. For this reason, there is no possibility that the vertex part of the segment of the above-mentioned center section may eat into an outer shell part, and big stress may occur.
[0017]Since the honeycomb structured body according to claim 5 is divided into the above-mentioned center section, pars intermedia, and the above-mentioned outer shell part sequentially from the diameter direction inside, it can enlarge the whole honeycomb structured body more at a center section and an outer shell part compared with what is divided into two to a diameter direction.
[0018]Here in the honeycomb structured body according to claim 6. The above-mentioned pars intermedia is divided into a hoop direction only the number below the number of partitions of the above-mentioned outer shell part, and while only the number below the number of partitions of the above-mentioned pars intermedia is divided into a hoop direction, the above-mentioned center section, Since the hoop direction position of the parting plane of the above-mentioned pars intermedia agreed in the hoop direction position of the parting plane of the above-mentioned outer shell part and the hoop direction position of the parting plane of the above-mentioned center section has agreed in the hoop direction position of the parting plane of the above-mentioned pars intermedia, Even if the peak which originates in the size error of each segment of a center section, etc., and touches the above-mentioned parting plane of this segment in the case of thermal expansion projects on the diameter direction outside, Since an outer shell part and pars intermedia are divided into the hoop direction in this projecting portion, each segment of these outer shell parts and pars intermedia can escape to a hoop direction, and there is no possibility that big stress may occur in an outer shell part and pars intermedia, like the honeycomb structured body according to claim 3.
[0019]Since the above-mentioned center section was made into polygonal shape and the hoop direction position of the parting plane of the above-mentioned pars intermedia and an outer shell part has agreed in the hoop direction position of the peak of this center section in the honeycomb structured body according to claim 7, Even if that vertex part projects on the diameter direction outside in the case of the thermal expansion of a center section, since an outer shell part and pars intermedia are divided into the hoop direction in this projecting

portion, each segment of these outer shell parts and pars intermedia can escape to a hoop direction, There is no possibility that big stress may occur in an outer shell part and pars intermedia, like the honeycomb structured body according to claim 4.

[0020]

[Example]The 1st example of this invention is described based on drawing 1 (a) and drawing 2. Although this example shows the example which used the honeycomb structured body of this invention for the catalytic combustion apparatus, it is also possible to use as the heat-regenerative element or radiator of the heat energy which the honeycomb structured body in particular of this invention does not ask that use, for example, a combustion gas etc. have, and a rectification means of a hot wind.

[0021]The gas turbine combustion device for NOx reduction shown in drawing 2 mainly comprises ******** 1, the premixing machine 3, the catalyst cassette 5, and the bypass air valve 7.

[0022]******** 1 comprises a usual flame combustion burner.

At the time of starting of a turbine, it operates in the amount of high combustion, and at the time of regular, it operates in the amount of low combustion to such an extent that the air introduced into a burner can be preheated to catalyzed combustion starting temperature.

The premixing machine 3 mixes the main fuel A to the preheated air C, and forms uniform gaseous mixture.

[0023]Two or more fuel catalyst bodies which consist of the honeycomb structured body 10 inside the cylindrical member 8 which consists of metal etc. arrange the catalyst cassette 5 in shaft orientations, and it is loaded, The above-mentioned cylindrical member 8 forms the channel of the above-mentioned gaseous mixture, and each honeycomb structured body 10 is arranged at the direction from which the direction of this channel (longitudinal direction of drawing 2) and the direction of many through holes of the above-mentioned honeycomb structured body 10 become abbreviated parallel. Therefore, by supplying the lean premix mind formed in this catalyst cassette 5 with said premixing machine 3, this premixed air burns stably within a catalyst bed, and generating of NOx is controlled substantially.

[0024]The bypass air valve 7 performs air supply for adjusting the inlet temperature (combustion exhaust temperature) of the turbine of figure abbreviation, and the maximum temperature of catalyzed combustion.

[0025]Drawing 1 (a) looks at the above-mentioned honeycomb structured body 10 from the above-mentioned passage direction. This honeycomb structured body 10 consists of the four center-section segments 11 divided into the hoop direction, and the eight outer shell part segments 12 divided into the hoop direction, and integral moulding of each segments 11 and 12 is carried out to honeycomb shape with various ceramics materials, a high-heat-resistance metallic material, etc.

[0026]Shape (namely, shape which combined the four center-section segments 11) of the whole center section is made into a right octagon, and if it puts in another way, let each center-section segment 11 be the shape which quadrisected the right octagon at the four vertices. It is supposed that it is circular and the peripheral face of each outer shell part segment 12 is made into the flat surface along the inner skin of the above-mentioned cylindrical member 8 where the medial surface of each outer shell part segment 12 agrees with the lateral surface of each above-mentioned center-section segment 11.

[0027]Therefore, a center section has a total of four parting planes 21, and an outer shell part has a total of eight parting planes 22, Each parting planes 21 and 22 are prolonged in the diameter direction of the honeycomb structured body 10 whole, and agreed with the hoop direction position of the parting plane 22, and the hoop direction position of the eight peaks of a center section will be agreed with the hoop direction position of the parting plane 22 by the hoop direction position of the four parting planes 21.

[0028]The total flow area of the outer shell part which consists of the eight outer shell part segments 12 is set as a feature of this honeycomb structured body 10 to 50% or less (the example of a figure 25.5%) of total (namely, flow area of the honeycomb structured body 10 whole) of the flow area of all the segments 11 and 12.

[0029]According to such a honeycomb structured body 10, the parting plane 20 of the part and center section where the outer shell part flow area is set to 50% or less of the total flow areas as mentioned above, and an outer shell part will approach the peripheral face of the honeycomb structured body 10. On the other hand, when using this honeycomb structured body 10 for the catalytic combustion device of above-mentioned drawing 2, incorporating it, Since it becomes low temperature rather than a center section by the heat dissipation to which the peripheral part of the honeycomb structured body 10 leads the cylindrical member 8 to the center section of this honeycomb structured body 10 being held by air blasting of a high-temperature fluid at an elevated temperature, in the honeycomb structured body 10, a remarkable temperature gradient arises in the portion near [that] the periphery. Therefore, by dividing the honeycomb structured body 10 by the above-mentioned parting plane 20 in the large part of this temperature gradient, or its neighborhood, generating of the heat stress resulting from the above-mentioned temperature gradient will be suppressed, and the life of honeycomb structured body 10 self will be extended.

[0030]In this honeycomb structured body 10, since shape of the center section is made into polygonal shape (the shape of an octagon [The example of a figure]), the above-mentioned parting plane 20 turns into a flat surface altogether, and becomes easy [field doubling of both the segments 11 and 12] that much. And since the hoop direction position of the vertex of the above-mentioned polygon has agreed with the hoop direction position of the parting plane 22 of the above-mentioned outer shell part, Even if the above-mentioned vertex part projects on

the diameter direction outside in the case of the thermal expansion of the center-section segment 11 (drawing 1 (a) arrow A1), in order that both the outer shell part segment 12 may escape by both side in this projecting portion (the figure arrow A2), the above-mentioned vertex part eats into the outer shell part segment 12, and big stress does not occur.

[0031]As shown in drawing 1 (b), in the structure where the hoop direction position of the center portion crack surface 21 has not agreed with the hoop direction position of the outer shell part parting plane 22. For the reasons of a size error etc., for example, when the right-hand side center-section segment 11 has projected on the diameter direction outside rather than the left-hand side center-section segment 11 in the E section of the figure, Although there is a possibility that the top part (top part which is in contact with the parting plane 21) 11a of the center-section segment 11 of the above-mentioned right-hand side may eat into the medial surface of the outer shell part segment 12, in the case of thermal expansion, If the hoop direction position of the biparite crack surfaces 21 and 22 is made to agree as shown in above-mentioned drawing 1 (a), even if each center-section segment 11 has a size gap of the above diameter directions, there will be no possibility that this center-section segment 11 may eat into the medial surface of the outer shell part segment 12, and generating of the stress by this will also be prevented.

[0032]It has shape (namely, shape whose flow areas of an outer shell part are 25.5% of the total flow areas) equivalent to the shape shown by an experiment and analytical-data A aforementioned drawing 1 (a), The 20-mm-thick manganese substitution type hexa aluminate catalyst honeycomb structured body whose number of cells is 300-/in^2. (an example article is called hereafter.) -- the catalytic combustion device for 150kw gas turbines shown in said drawing 2 being equipped, and, It has checked that there was no crack in a honeycomb structured body, and it could be equal to starting, steady operation, and gas turbine operation that consists of stops also at long-term use when a predetermined time line investigates a honeycomb structured body. On the other hand, it is a honeycomb structured body of the same size as the above-mentioned honeycomb structured body, Only what only quadrisected the whole into the hoop direction (that is, below thing; that is not divided in a diameter direction.) A comparison article is called. When it used and the above-mentioned gas turbine operation was performed on the completely same conditions, remarkable breakage was seen in the width field from a peripheral face to 50 mm, especially the width field from a peripheral face to 20 mm, and it has checked that use beyond it could not be expected.

[0033]When heat stress analysis is conducted about the above-mentioned example article and a comparison article, the maximum heat stress of a comparison article With an example article, it is as the maximum heat stress to being 6.24MPa. A very small value called 1.532MPa was able to be obtained.

[0034]B) 5 division honeycomb structured body 10 which consists of the single square-like

center-section segment 11 and the four outer shell part segments 12 which surround this as shown in drawing 3, About 12 division honeycomb structured body 10 shown in said drawing 1, whole honeycomb structured body diameter:220mm, Cell interval : 1.4 mm, cell thickness and envelope thickness:0.25mm, center-section temperature:1000 **, The peripheral face temperature of 800 **, a temperature-change region : As a result of conducting heat stress analysis by a computer on the conditions of the field from a peripheral face to 5 mm, linear dimension c (refer to drawing 3) of the parting plane 22 of the outer shell part segment 12 above, About the relation with maximum tensile stress sigmamax, the graph as shown in drawing 4 was able to be obtained. From this graph, he can understand that maximum tensile stress sigmamax decreases, so that the above-mentioned linear dimension c is set up small (i.e., so that an outer shell part flow area is set up small).

[0035]C) In the honeycomb structured body (220 phi) which quadrisected the square-like center section into the hoop direction in the straight line which connects the middle points of the neighborhood, and quadrisected the outer shell part into the hoop direction in the position of the square vertex of the above-mentioned center section, When the thermo couple was attached to the suitable position and the actual temperature gradient was measured, in the field from the center to 105 mm in radius, there is almost no temperature gradient and it became clear that the temperature gradient was concentrating on the peripheral part with a width [in the diameter direction outside] of 5 mm.

[0036]Setting the flow area of an outer shell part from the result of the above ABC to 50% or less of the total flow areas like this invention, He can understand that the crack by heat stress can be prevented still more certainly by being able to understand that it is very effective on heat stress reduction, and suppressing the above-mentioned area rate from the result of A to 30% or less especially, or suppressing the minimum width size of an outer shell part to 20 mm or less.

[0037]what is necessary is just to set up the shape of the whole center section freely in the above-mentioned example, and it sets up in the shape of [as shown in drawing 5] a perfect circle -- it may be made like (that is, each center-section segment 11 is made into a sector). It becomes possible by doubling the hoop direction position of the parting plane 21 of a center section with the hoop direction position of the parting plane 22 of an outer shell part also in this case to lower stress more effectively.

[0038]Next, the 2nd example is described based on drawing 6.

[0039]In this example, the honeycomb structured body 10 whole sequentially from that diameter direction inside The center section of the right octagon, It is trichotomized by pars intermedia and the outer shell part, the above-mentioned center section is divided into the four center-section segments 11 like said 1st example, and pars intermedia and an outer shell part are divided into the outer shell part segment 12 of eight pars intermedia segments [13 or 8],

respectively.
[0040]Thus, even if the size which can carry out integral moulding of the honeycomb structured body even if by increasing the number of partitions of a diameter direction is restricted, By finishing setting up many segments 11-13, the honeycomb structured body 10 of a large area can be formed more as a whole, thereby, the amount of gassing can be increased in a catalyst device, and passage resistance can be reduced in a heat energy accumulator or a hot wind rectifier.
[0041]The hoop direction position of the omitted portion crack surface 23 is made to agree in the hoop direction position of the outer shell part parting plane 22, as shown in above-mentioned drawing 6, And it can prevent the top part of the center-section segment 11 eating into the pars intermedia segment 12, and heat stress increasing by making the hoop direction position of the center portion crack surface 21, and the hoop direction position of each peak of a center section agree in the hoop direction position of the above-mentioned omitted portion crack surface 23.
[0042]Although the number of the pars intermedia segment 13, the number of the outer shell part segment 12, etc. were carried out and that of the potato was shown in this example, there may be more number of the outer shell part segment 12 than the number of the pars intermedia segment 13, and it may be made to divide an outer shell part into 16, as shown in drawing 7 as the 3rd example. What is necessary is just to make the hoop direction position of each vertex of this pars intermedia agree in the hoop direction position of the parting plane 22 of an outer shell part here, when making outer peripheral surface shape of the whole pars intermedia into a polygon (the example of a figure 16 square shapes), as shown in the figure.
[0043]If the pars intermedia segment 13 in this honeycomb structured body 10 is divided into the inside segment 14 and the outside segment 15 as shown in drawing 8 as the 4th example, the honeycomb structured body 10 of a large area can be obtained further. Also in this case, it is considered as >=(number of outer shell part segments 12) (number of outside segments 15) >=(number of inside segments 14) >= (the number of the center-section segments 11), The hoop direction position of the middle lateral part crack surface 25 is made to agree in the hoop direction position of the outer shell part parting plane 22, A still more desirable thing is obtained by making the hoop direction position of the middle inner portion parting plane 24 agree in the hoop direction position of the middle lateral part crack surface 25, and making the hoop direction position and center-section vertex position of the center portion crack surface 21 agree in the hoop direction position of the middle inner portion parting plane 24.
[0044]
[Effect of the Invention]As mentioned above, by this invention, while dividing into a diameter direction the honeycomb structured body provided inside the cylindrical member which forms the channel of a high-temperature fluid at a center section and an outer shell part and dividing

an outer shell part into a hoop direction, the flow area of an outer shell part is set to 50% or less of the total flow areas.
Therefore, compared with the former, in a honeycomb structured body, can bring the diameter direction position of the parting plane of the above-mentioned center section and a dividing part close to the remarkable portion of a temperature gradient, and most by this, The heat stress which originates in the above-mentioned temperature gradient and is generated is controlled substantially, and it is effective in the life of a honeycomb structured body being substantially extensible.

[0045]In particular, by [according to claim 2] setting the flow area of the above-mentioned outer shell part to 30% or less of the total flow areas like, the parting plane of an outer shell part and a center section can be close brought by the most remarkable portion of the above-mentioned temperature gradient, and the above-mentioned heat stress can be reduced further.

[0046]In the honeycomb structured body according to claim 3, since the above-mentioned center section is divided into the hoop direction, even if the size which can carry out integral moulding of the honeycomb structured body has a limitation, a bigger center section can be formed by the above-mentioned division. And since the number of partitions of this center section was set as the number below the number of partitions of the above-mentioned outer shell part and the hoop direction position of the parting plane of this center section has agreed in the hoop direction position of the parting plane of the above-mentioned outer shell part, Even if the peak which originates in the size error of each segment of a center section, etc., and touches the above-mentioned parting plane of this segment in the case of thermal expansion projects on the diameter direction outside, It can prevent this nosing's eating into an outer shell part, and generating new stress, and the life extension effect of a honeycomb structured body can fully be secured.
[0047]In the honeycomb structured body according to claim 4, since the above-mentioned center section is made into polygonal shape, by making the parting plane of this center section and outer shell part into a flat surface, field doubling of these center sections and an outer shell part can be made easy, and a manufacturing cost can be reduced. And since the hoop direction position of the peak of this center section and the hoop direction position of the parting plane of the above-mentioned outer shell part have agreed, Even if that vertex part projects on the diameter direction outside in the case of the thermal expansion of a center section, it can prevent this nosing's eating into an outer shell part, and generating new stress, and the life extension effect of a honeycomb structured body can fully be secured.
[0048]Since the honeycomb structured body according to claim 5 is divided into the above-mentioned center section, pars intermedia, and the above-mentioned outer shell part

sequentially from the diameter direction inside, the effect that the whole honeycomb structured body is more enlargeable compared with what is divided into two to a center section and an outer shell part is in a diameter direction.

[0049]Also in this honeycomb structured body according to claim 5, like the honeycomb structured body according to claim 6, While only the number below the number of partitions of the above-mentioned outer shell part divides the above-mentioned pars intermedia into a hoop direction and only the number below the number of partitions of the above-mentioned pars intermedia divides the above-mentioned center section into a hoop direction, By making the hoop direction position of the parting plane of the above-mentioned pars intermedia agree in the hoop direction position of the parting plane of the above-mentioned outer shell part, and making the hoop direction position of the parting plane of the above-mentioned center section agree in the hoop direction position of the parting plane of the above-mentioned pars intermedia, It can prevent this nosing's eating into an outer shell part, and generating new stress, even if the peak which originates in the size error of each segment of a center section, etc., and touches the above-mentioned parting plane of this segment like the honeycomb structured body according to claim 3 in the case of thermal expansion projects on the diameter direction outside, The life extension effect of a honeycomb structured body is fully securable. By [according to claim 7] making the above-mentioned center section into polygonal shape, and making the hoop direction position of the parting plane of the above-mentioned pars intermedia and an outer shell part agree in the hoop direction position of the peak of this center section like, Like the honeycomb structured body according to claim 4, even if that vertex part projects on the diameter direction outside in the case of the thermal expansion of a center section, it can prevent this nosing's eating into an outer shell part, and generating new stress, and the life extension effect of a honeycomb structured body can fully be secured.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1](a) is a front view of the honeycomb structured body in the 1st example of this invention, and a front view in which (b) shows the modification of the honeycomb structured body.
[Drawing 2]It is a section side view of the catalytic combustion apparatus with which the above-mentioned honeycomb structured body is used.
[Drawing 3]It is a front view showing the structure of the honeycomb structured body used as the model of heat stress analysis.
[Drawing 4]It is a graph which shows the relation of the linear dimension of an outer shell part parting plane and the maximum tensile stress which were obtained in the above-mentioned heat stress analysis.
[Drawing 5]It is a front view showing the modification of the above-mentioned honeycomb structured body.
[Drawing 6]It is a front view of the honeycomb structured body in the 2nd example of this invention.
[Drawing 7]It is a front view of the honeycomb structured body in the 3rd example of this invention.
[Drawing 8]It is a front view of the honeycomb structured body in the 4th example of this invention.
[Description of Notations]
8 Cylindrical member
10 Honeycomb structured body
11 Center-section segment
12 Outer shell part segment
13 Pars intermedia segment

14 Inside segment
15 Outside segment
20 The parting plane of a center section and an outer shell part
21 The parting plane of a center section
22 The parting plane of an outer shell part
23 The parting plane of pars intermedia
24 The parting plane of a middle inner portion
25 The parting plane of a middle lateral part

[Translation done.]

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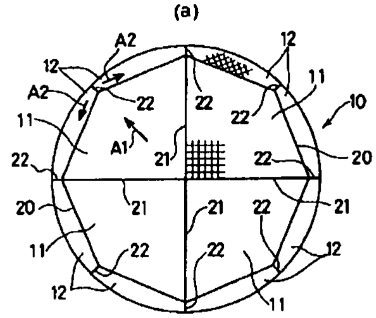
(54)【発明の名称】　ハニカム構造体

(57)【要約】

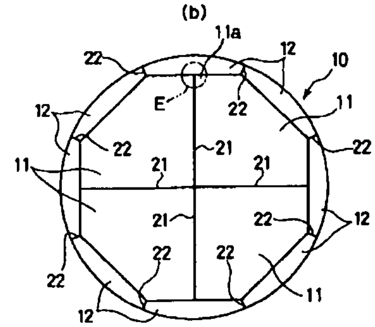
【目的】　ハニカム構造体の十分な流路面積を確保しながら、熱応力による破損を防いで寿命延長を図る。

【構成】　高温流体流路を形成する筒状部材の内側に配されるハニカム構造体１０を、径方向について、中央部セグメント１１と外殻部セグメント１２とに分割する。外殻部流路面積、すなわち外殻部セグメント１２の流路面積の総和を、ハニカム構造体１０全体の流路面積、すなわち全セグメント１１，１２の流路面積の総和の５０％以下とする。

(a)



(b)



【特許請求の範囲】

【請求項１】　互いに平行な多数の貫通穴を有し、高温流体の流路を形成する筒状部材の内側にその流路方向と上記貫通穴とが略平行となる向きに配されるハニカム構造体において、このハニカム構造体を上記筒状部材の径方向について中央部とこの中央部の周囲を取り巻く外殻部とに分割し、上記外殻部を周方向に分割するとともに、この外殻部の流路面積がハニカム構造体全体の流路面積の５０％以下となるように上記中央部及び外殻部の形状を設定したことを特徴とするハニカム構造体。

【請求項２】　請求項１記載のハニカム構造体において、上記外殻部の流路面積がハニカム構造体全体の流路面積の３０％以下となるように上記中央部及び外殻部の形状を設定したことを特徴とするハニカム構造体。

【請求項３】　請求項１または２記載のハニカム構造体において、上記中央部を上記外殻部の分割数以下の数だけ周方向に分割するとともに、この中央部の分割面の周方向位置を上記外殻部の分割面の周方向位置に合致させたことを特徴とするハニカム構造体。

【請求項４】　請求項１～３のいずれかに記載のハニカム構造体において、上記中央部を上記外殻部の分割数以下の数の頂点をもつ多角形状とし、この中央部の頂点の周方向位置と上記外殻部の分割面の周方向位置とを合致させたことを特徴とするハニカム構造体。

【請求項５】　請求項１～４のいずれかに記載のハニカム構造体において、このハニカム構造体を径方向内側から順に上記中央部、中間部、及び上記外殻部に分割したことを特徴とするハニカム構造体。

【請求項６】　請求項５記載のハニカム構造体において、上記中間部を上記外殻部の分割数以下の数だけ周方向に分割し、上記中央部を上記中間部の分割数以下の数だけ周方向に分割するとともに、上記中間部の分割面の周方向位置を上記外殻部の分割面の周方向位置に合致させ、上記中央部の分割面の周方向位置を上記中間部の分割面の周方向位置に合致させたことを特徴とするハニカム構造体。

【請求項７】　請求項５または６記載のハニカム構造体において、上記中央部を上記中間部の分割数以下の頂点をもつ多角形状とし、この中央部の頂点の周方向位置と上記中間部の分割面の周方向位置及び外殻部の分割面の周方向位置とを合致させたことを特徴とするハニカム構造体。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、①ＮＯｘ低減用燃焼触媒、②熱エネルギの蓄熱体または輻射体、③熱風の整流手段、等に用いられるハニカム構造体に関するものである。

【０００２】

【従来の技術】一般に、上記のような目的で使用されるハニカム構造体は、コージェライト、アルミナ、ＳｉＣといったセラミックス等によりハニカム状に形成されており、高温流体の流路を形成する筒状部材の内側に、この高温流体の流路とハニカム構造体自身の多数の貫通穴とが略平行となる向きに配され、上記貫通穴に上記高温流体を流すようにして使用される。例えば、特開平５－２３１６０８号公報には、パラジウム、白金等の貴金属をアルミナ等のコーティング材を介してコーディエライトハニカム基体に担持させることにより板状の燃焼触媒体が構成され、この燃焼触媒体が筒状部材の内側に配置されたＮＯｘ低減用の触媒燃焼装置が開示されている。

【０００３】ところで、このような燃焼装置におけるガス処理量を増大させたり、上記筒状部材内での通風抵抗を下げたりするには、上記ハニカム構造体の流路面積を大きく設定することが有効であるが、ハニカムの寸法精度及び強度を良好に維持しながらハニカム構造体全体を一体成形できる大きさには自ずから限界がある。また、上記筒状部材内でのガス流動を均一にすることは難しいため、ハニカム構造体平面上での位置的な温度変化は避けがたく、熱衝撃によりハニカム構造体が破損しやすい不都合がある。特に、セラミックス製ハニカム構造体は脆性が高いため、比較的小さい応力でも割れ等が発生するおそれがある。

【０００４】このような不都合を解消する手段として、ハニカム構造体の材料自身のヤング率を大きくしたり、小型の筒状部材をマルチ型に並列に接続したりすることが考えられるが、前者の場合、材料改質には自ずから限界があり、また、このような改質の結果、本来必要とされる特性を損ない易い欠点がある。一方、後者の場合には、装置全体が大型化し、また複雑となる欠点がある。

【０００５】そこで従来は、上記ハニカム構造体を上記流路方向と直交する方向に複数の小さなセグメント（互いに流路面積のほぼ等しいセグメント）に分割し、これらのセグメントを組み上げることにより全体として大面積のハニカム構造体を得るようにする技術が提案されている。例えば上記公報には、ハニカム構造体を中央の円形状セグメントと、この円形状セグメントを取り巻く複数（例えば８個）の外側セグメントとに分割し、上記円形状セグメントの半径がハニカム構造体全体の半径の約半分に設定されたものが示されている。このような構造によれば、全体が一体成形された大きなハニカム構造体に比べ、膨張率は等しくても各セグメントの絶対膨張量は少なくなり、その分、熱応力に起因する破壊は生じにくくなる。

【０００６】

【発明が解決しようとする課題】上記公報に示されるようなハニカム構造体においても、これを長期間使用すると、特に外周部（具体的には外周面から内側に5mm～20mmの幅の領域、大きくても50mm以下の領域）で亀裂が生じやすいことが判明されており、このようなハニカム構

造体の長期的な使用に対する耐久性が大きな課題とされている。

【０００７】本発明は、このような事情に鑑み、十分な流路面積を確保しながら、その寿命を効果的に延長することができるハニカム構造体を提供することを目的とする。

【０００８】

【課題を解決するための手段】本発明者等は、上記のようなハニカム構造体について検討を行った結果、このハニカム構造体の外周面は筒状部材と接触していて放熱し易いため、ハニカム構造体に高温流体が送風されている状態ではこのハニカム構造体の中央部に比べて外周面の温度が低く、逆にハニカム構造体に冷却用流体が送風されている状態では上記中央部に比べて外周面の温度が高くなり、いずれの場合もハニカム構造体外周面の直ぐ内側の領域で著しい温度勾配が発生し、この温度勾配の大きな領域で熱衝撃による破壊が生じることを突き止めた。

【０００９】本発明は、このような検討の結果なされたものであり、互いに平行な多数の貫通穴を有し、高温流体の流路を形成する筒状部材の内側にその流路方向と上記貫通穴とが略平行となる向きに配されるハニカム構造体において、このハニカム構造体を上記筒状部材の径方向について中央部とこの中央部の周囲を取り巻く外殻部とに分割し、上記外殻部を周方向に分割するとともに、この外殻部の流路面積がハニカム構造体全体の流路面積の５０％以下（請求項２では３０％以下）となるように上記中央部及び外殻部の形状を設定したものである(請求項１)。

【００１０】このハニカム構造体は、上記中央部を上記外殻部の分割数以下の数だけ周方向に分割するとともに、この中央部の分割面の周方向位置を上記外殻部の分割面の周方向位置に合致させたり（請求項３）、上記中央部を上記外殻部の分割数以下の数の頂点をもつ多角形状とし、この中央部の頂点の周方向位置と上記外殻部の分割面の周方向位置とを合致させたりする（請求項４）ことにより、さらに好ましいものとなる。

【００１１】また、このハニカム構造体を径方向内側から順に上記中央部、中間部、及び上記外殻部に分割することにより、後述のようなより優れた効果が得られる（請求項５）。

【００１２】この場合も、請求項６記載のように、上記中間部を上記外殻部の分割数以下の数だけ周方向に分割し、上記中央部を上記中間部の分割数以下の数だけ周方向に分割するとともに、上記中間部の分割面の周方向位置を上記外殻部の分割面の周方向位置に合致させ、上記中央部の分割面の周方向位置を上記中間部の分割面の周方向位置に合致させたり、請求項７記載のように、上記中央部を上記中間部の分割数以下の頂点をもつ多角形状とし、この中央部の頂点の周方向位置と上記中間部の分割面の周方向位置及び外殻部の分割面の周方向位置とを合致させたりすることにより、さらに好ましいものが得られる。

【００１３】

【作用】請求項１記載のハニカム構造体は、上記筒状部材の径方向に中央部とこの中央部の周囲を取り巻く外殻部とに分割されるとともに、上記外殻部が周方向に分割されているため、上記中央部が径方向外側に膨張しても、外殻部に大きな周方向引張応力が発生することはない。しかも、この外殻部の流路面積がハニカム構造体全体の流路面積の５０％以下とされているため、その分、中央部と外殻部との分割面は従来よりもハニカム構造体外周面に近づく。すなわち、このハニカム構造体では、最も温度勾配の大きい部分もしくはその近傍でハニカム構造体が径方向に分割されることになる。ここで、ハニカム構造体に発生する熱応力は、温度変化による変形の拘束によって発生するひずみに起因して発生するものであるため、上記のように温度勾配の大きな部分もしくはこれに近い位置でハニカム構造体が中央部と外殻部とに分割されることにより、上記ひずみが解放され、もしくはその拘束が低減することになり、その分熱応力も大幅に低減する。

【００１４】特に、請求項２記載のハニカム構造体では、上記外殻部の流路面積がハニカム構造体全体の流路面積の３０％以下であるため、中央部と外殻部との分割面は外周面にさらに近づくことになり、これによって熱応力はさらに低減する。

【００１５】請求項３記載のハニカム構造体では、上記中央部が周方向に分割されているため、ハニカム構造体を一体成形できる大きさに限りがあっても、上記分割によってより大きな中央部を形成することが可能である。しかも、この中央部の分割数が上記外殻部の分割数以下の数に設定され、この中央部の分割面の周方向位置が上記外殻部の分割面の周方向位置に合致しているので、中央部の各セグメント（分割片）の寸法誤差等に起因して熱膨張の際にこのセグメントの上記分割面に接する頂点が径方向外側に突き出ても、この突き出る部分で外殻部が周方向に分割されているために外殻部の各セグメントは周方向に逃げることができる。このため、外殻部に上記中央部のセグメントの頂点部分が食い込んで大きな応力が発生するといったおそれがない。

【００１６】また、請求項４記載のハニカム構造体では、上記中央部が多角形状であるため、この中央部と外殻部との分割面は平面であり、その分これら中央部と外殻部との面合わせが容易になる。しかも、この中央部の頂点の周方向位置と上記外殻部の分割面の周方向位置とが合致しているので、中央部の熱膨張の際にその頂点部分が径方向外側に突き出ても、この突き出る部分で外殻部が周方向に分割されているために外殻部の各セグメントは周方向に逃げることができる。このため、外殻部に

上記中央部のセグメントの頂点部分が食い込んで大きな応力が発生するおそれがない。

【0017】請求項5記載のハニカム構造体は、径方向内側から順に上記中央部、中間部、及び上記外殻部に分割されているため、径方向に中央部と外殻部とにのみ2分割されているものに比べ、ハニカム構造体全体をより大型化できる。

【0018】ここで、請求項6記載のハニカム構造体では、上記中間部が上記外殻部の分割数以下の数だけ周方向に分割され、上記中央部が上記中間部の分割数以下の数だけ周方向に分割されるとともに、上記中間部の分割面の周方向位置が上記外殻部の分割面の周方向位置に合致し、上記中央部の分割面の周方向位置が上記中間部の分割面の周方向位置に合致しているため、中央部の各セグメントの寸法誤差等に起因して熱膨張の際にこのセグメントの上記分割面に接する頂点が径方向外側に突き出ても、この突き出る部分で外殻部及び中間部が周方向に分割されているためにこれら外殻部及び中間部の各セグメントは周方向に逃げることができ、請求項3記載のハニカム構造体と同様、外殻部及び中間部に大きな応力が発生するおそれがない。

【0019】また、請求項7記載のハニカム構造体では、上記中央部が多角形状とされ、この中央部の頂点の周方向位置に上記中間部及び外殻部の分割面の周方向位置が合致しているため、中央部の熱膨張の際にその頂点部分が径方向外側に突き出ても、この突き出る部分で外殻部及び中間部が周方向に分割されているためにこれら外殻部及び中間部の各セグメントは周方向に逃げることができ、請求項4記載のハニカム構造体と同様、外殻部及び中間部に大きな応力が発生するおそれがない。

【0020】

【実施例】本発明の第1実施例を図1（ａ）及び図2に基づいて説明する。なお、この実施例では、本発明のハニカム構造体を触媒燃焼装置に用いた例を示すが、本発明のハニカム構造体はその用途を特に問わず、例えば、燃焼排ガス等のもつ熱エネルギの蓄熱体あるいは輻射体や、熱風の整流手段として用いることも可能である。

【0021】図2に示すＮＯｘ低減用ガスタービン燃焼器は、主として予燃焼器１、予混合器３、触媒カセット５、及びバイパス空気弁７から構成されている。

【0022】予燃焼器１は、通常の火炎燃焼バーナで構成されており、タービンの起動時には高燃焼量で作動し、定常時には、燃焼器に導入される空気を触媒燃焼開始温度まで予熱できる程度に低燃焼量で作動する。予混合器３は、予熱された空気Ｃに主燃料Ａを混合し、均一な混合気を形成するものである。

【0023】触媒カセット５は、金属等からなる筒状部材８の内側に、ハニカム構造体１０からなる複数の燃料触媒体が軸方向に並べて装填されたものであり、上記筒状部材８は上記混合気の流路を形成し、この流路の方向（図２の左右方向）と上記ハニカム構造体１０の多数の貫通穴の方向とが略平行になる向きに各ハニカム構造体１０が配置されている。従って、この触媒カセット５に前記予混合器３で形成された希薄予混合気が供給されることにより、この予混合気が触媒層内で安定に燃焼され、ＮＯｘの発生が大幅に抑制される。

【0024】なお、バイパス空気弁７は、図略のタービンの入口温度（燃焼排気温度）及び触媒燃焼の最高温度を調節するための空気供給を行うものである。

【0025】図１（ａ）は、上記ハニカム構造体１０を上記流路方向から見たものである。このハニカム構造体１０は、周方向に分割された４つの中央部セグメント１１と、周方向に分割された８つの外殻部セグメント１２とからなり、各セグメント１１，１２は各種セラミックス材料や高耐熱性金属材料等によりハニカム状に一体成形されている。

【0026】中央部全体の形状（すなわち４つの中央部セグメント１１を組み合わせた形状）は正８角形とされ、換言すれば、各中央部セグメント１１は正８角形をその４つの頂点で４分割した形状とされている。各外殻部セグメント１２の外周面は上記筒状部材８の内周面に沿う円弧状とされ、各外殻部セグメント１２の内側面は上記各中央部セグメント１１の外側面と合致する平面とされている。

【0027】従って、中央部は合計４つの分割面２１を有し、外殻部は合計８つの分割面２２を有し、各分割面２１，２２はハニカム構造体１０全体の径方向に延びており、中央部の８つの頂点の周方向位置は分割面２２の周方向位置と合致し、４つの分割面２１の周方向位置も分割面２２の周方向位置と合致した状態になっている。

【0028】さらに、このハニカム構造体１０の特徴として、８個の外殻部セグメント１２からなる外殻部の総流路面積が、全てのセグメント１１，１２の流路面積の総和（すなわちハニカム構造体１０全体の流路面積）の５０％以下（図例では２５．５％）に設定されている。

【0029】このようなハニカム構造体１０によれば、上記のように外殻部流路面積が総流路面積の５０％以下に設定されている分、中央部と外殻部との分割面２０はハニカム構造体１０の外周面に近づくことになる。一方、このハニカム構造体１０を上記図２の触媒燃焼器に組み込んで使用する際には、このハニカム構造体１０の中央部は高温流体の送風で高温に保持されるのに対し、ハニカム構造体１０の外周部は筒状部材８を通じての放熱で中央部よりも低温となるため、ハニカム構造体１０においてその外周近傍の部分において著しい温度勾配が生じる。従って、この温度勾配の大きい個所もしくはその近傍においてハニカム構造体１０が上記分割面２０で分割されることにより、上記温度勾配に起因する熱応力の発生が抑えられ、ハニカム構造体１０自身の寿命が延長されることになる。

【００３０】さらに、このハニカム構造体１０では、中央部の形状が多角形状（図例では８角形状）とされているため、上記分割面２０は全て平面となり、その分両セグメント１１，１２の面合わせが容易となる。しかも、上記多角形の頂点の周方向位置が上記外殻部の分割面２２の周方向位置と合致しているので、中央部セグメント１１の熱膨張の際に上記頂点部分が径方向外側に突き出ても（図１（ａ）矢印Ａ１）、この突き出る部分で両外殻部セグメント１２が両脇に逃げるため（同図矢印Ａ２）、外殻部セグメント１２に上記頂点部分が食い込んで大きな応力が発生することもない。

【００３１】また、図１（ｂ）に示すように、中央部分割面２１の周方向位置が外殻部分割面２２の周方向位置と合致していない構造には、寸法誤差等の理由により例えば図のＥ部で右側の中央部セグメント１１が左側の中央部セグメント１１よりも径方向外側に突出している場合、熱膨張の際に上記右側の中央部セグメント１１の頂点部（分割面２１に接している頂点部）１１ａが外殻部セグメント１２の内側面に食い込むおそれがあるが、上記図１（ａ）に示すように両分割面２１，２２の周方向位置を合致させておけば、各中央部セグメント１１に上記のような径方向の寸法ずれがあってもこの中央部セグメント１１が外殻部セグメント１２の内側面に食い込むおそれがなく、これによる応力の発生も防がれる。

【００３２】実験及び解析データ

Ａ）前記図１（ａ）で示した形状と同等の形状（すなわち外殻部の流路面積が総流路面積の２５．５％である形状）を有し、セル数が300/in²、厚さが20mmであるマンガン置換型ヘキサアルミネート触媒ハニカム構造体（以下、実施例品と称する。）を前記図２に示した150kwガスタービン用触媒燃焼器に装着し、起動、定常運転、及び停止からなるガスタービン運転を所定時間行ってハニカム構造体を調査したところ、ハニカム構造体には亀裂がなく、長期的な使用にも耐え得ることが確認できた。これに対し、上記ハニカム構造体と同じサイズのハニカム構造体であって、全体を単に周方向に４分割しただけのもの（すなわち径方向には分割しないもの；以下、比較品と称する。）を用いて全く同じ条件で上記ガスタービン運転を行ったところ、外周面から50mmまでの幅領域、特に外周面から20mmまでの幅領域で著しい破損が見られ、それ以上の使用は望めないことが確認できた。

【００３３】また、上記実施例品及び比較品について熱応力解析を行ったところ、比較品の最大熱応力が 6.24MPaであるのに対し、実施例品では最大熱応力として 1.532MPa という非常に小さい値を得ることができた。

【００３４】Ｂ）図３に示すように、単一の正方形状中央部セグメント１１とこれを取り巻く４つの外殻部セグメント１２とからなる５分割ハニカム構造体１０と、前記図１に示した１２分割ハニカム構造体１０とについて、ハニカム構造体全体直径：220mm、セル間隔：1.4mm、セル厚み及び外皮厚み：0.25mm、中央部温度：1000℃、外周面温度800℃、温度変化域：外周面から５mmまでの領域、という条件でコンピュータによる熱応力解析を行った結果、上記外殻部セグメント１２同士の分割面２２の長さ寸法ｃ（図３参照）と、最大引張応力σmaxとの関係について、図４に示すようなグラフを得ることができた。このグラフから、上記長さ寸法ｃを小さく設定するほど、すなわち外殻部流路面積を小さく設定するほど、最大引張応力σmaxが減少することが理解できる。

【００３５】Ｃ）正方形状の中央部をその辺の中点同士を結ぶ直線で周方向に４分割し、外殻部を上記中央部の正方形頂点の位置で周方向に４分割したハニカム構造体（220φ）において、その適当な位置に熱電対を取付け、実際の温度勾配を測定したところ、その中心から半径105mmまでの領域ではほとんど温度勾配がなく、その径方向外側における幅5mmの外周部に温度勾配が集中していることが判明した。

【００３６】以上のＡ）Ｂ）Ｃ）の結果から、本発明のように外殻部の流路面積を総流路面積の５０％以下に設定することが、熱応力低減の上で非常に有効であるということが理解でき、特にＡ）の結果から、上記面積率を３０％以下に抑え、あるいは外殻部の最小幅寸法を20mm以下に抑えることにより、熱応力による亀裂をさらに確実に防止できることが理解できる。

【００３７】なお、上記実施例において中央部全体の形状は自由に設定すれば良く、図５に示すような真円状に設定する（すなわち各中央部セグメント１１を扇形にする）ようにしてもよい。この場合も、中央部の分割面２１の周方向位置を外殻部の分割面２２の周方向位置に合わせることにより、応力をより効果的に下げることが可能になる。

【００３８】次に、第２実施例を図６に基づいて説明する。

【００３９】この実施例では、ハニカム構造体１０全体がその径方向内側から順に正８角形の中央部、中間部、及び外殻部に３分割され、上記中央部は前記第１実施例と同様に４つの中央部セグメント１１に分割され、中間部及び外殻部は８つの中間部セグメント１３、８つの外殻部セグメント１２にそれぞれ分割されている。

【００４０】このように、径方向の分割数を増やすことにより、たとえハニカム構造体を一体成形できる大きさが限られていても、多数のセグメント１１～１３を組み上げることにより全体としてより大面積のハニカム構造体１０を形成することができ、これにより、触媒装置においてはそのガス処理量を増加でき、熱エネルギ蓄熱装置や熱風整流装置においては流路抵抗を削減することができる。

【００４１】また、上記図６に示すように、中間部分割面２３の周方向位置を外殻部分割面２２の周方向位置に

合致させ、かつ、中央部分割面２１の周方向位置並びに中央部の各頂点の周方向位置を上記中間部分割面２３の周方向位置に合致させることにより、中間部セグメント１２に中央部セグメント１１の頂点部が食い込んで熱応力が増大するのを防ぐことができる。

【００４２】この実施例では、中間部セグメント１３の個数と外殻部セグメント１２の個数とが等しいものを示したが、外殻部セグメント１２の個数は中間部セグメント１３の個数より多くても良く、第３実施例として図７に示すように、外殻部を１６分割するようにしてもよい。ここで、同図のように中間部全体の外周面形状を多角形（図例では１６角形）にする場合には、この中間部の各頂点の周方向位置を外殻部の分割面２２の周方向位置に合致させればよい。

【００４３】さらに、このハニカム構造体１０における中間部セグメント１３を、第４実施例として図８に示すように内側セグメント１４と外側セグメント１５とに分割すれば、さらに大面積のハニカム構造体１０を得ることができる。この場合も、（外殻部セグメント１２の数）≧（外側セグメント１５の数）≧（内側セグメント１４の数）≧（中央部セグメント１１の数）とし、外殻部分割面２２の周方向位置に中間外側部分割面２５の周方向位置を合致させ、中間外側部分割面２５の周方向位置に中間内側部分割面２４の周方向位置を合致させ、中間内側部分割面２４の周方向位置に中央部分割面２１の周方向位置及び中央部頂点位置を合致させることにより、さらに好ましいものが得られる。

【００４４】

【発明の効果】以上のように本発明は、高温流体の流路を形成する筒状部材の内側に設けられるハニカム構造体を径方向に中央部と外殻部とに分割し、外殻部を周方向に分割するとともに、外殻部の流路面積を総流路面積の５０％以下に設定したものであるので、従来に比べ、上記中央部と分割部との分割面の径方向位置を、ハニカム構造体において最も温度勾配の著しい部分に近付けることができ、これにより、上記温度勾配に起因して発生する熱応力を大幅に抑制し、ハニカム構造体の寿命を大幅に延長することができる効果がある。

【００４５】特に、請求項２記載のように上記外殻部の流路面積を総流路面積の３０％以下に設定することにより、外殻部と中央部との分割面を上記温度勾配の最も著しい部分により近付けることができ、上記熱応力をさらに低減することができる。

【００４６】請求項３記載のハニカム構造体では、上記中央部が周方向に分割されているため、ハニカム構造体を一体成形できる大きさに限りがあっても、上記分割によってより大きな中央部を形成することができる。しかも、この中央部の分割数が上記外殻部の分割数以下の数に設定され、この中央部の分割面の周方向位置が上記外殻部の分割面の周方向位置に合致しているので、中央部の各セグメントの寸法誤差等に起因して熱膨張の際にこのセグメントの上記分割面に接する頂点が径方向外側に突き出ても、この突き出た部分が外殻部に食い込んで新たな応力を発生させるのを防ぐことができ、ハニカム構造体の寿命延長効果を十分に確保することができる。

【００４７】また、請求項４記載のハニカム構造体では、上記中央部を多角形状としているので、この中央部と外殻部との分割面を平面とすることにより、これら中央部と外殻部との面合わせを容易にし、製造コストを削減することができる。しかも、この中央部の頂点の周方向位置と上記外殻部の分割面の周方向位置とが合致しているので、中央部の熱膨張の際にその頂点部分が径方向外側に突き出ても、この突き出た部分が外殻部に食い込んで新たな応力を発生させるのを防ぐことができ、ハニカム構造体の寿命延長効果を十分に確保することができる。

【００４８】請求項５記載のハニカム構造体は、径方向内側から順に上記中央部、中間部、及び上記外殻部に分割されているため、径方向に中央部と外殻部とにのみ２分割されているものに比べ、ハニカム構造体全体をより大型化することができる効果がある。

【００４９】この請求項５記載のハニカム構造体においても、請求項６記載のハニカム構造体のように、上記中間部を上記外殻部の分割数以下の数だけ周方向に分割し、上記中央部を上記中間部の分割数以下の数だけ周方向に分割するとともに、上記中間部の分割面の周方向位置を上記外殻部の分割面の周方向位置に合致させ、上記中央部の分割面の周方向位置を上記中間部の分割面の周方向位置に合致させることにより、請求項３記載のハニカム構造体と同様に、中央部の各セグメントの寸法誤差等に起因して熱膨張の際にこのセグメントの上記分割面に接する頂点が径方向外側に突き出てもこの突き出た部分が外殻部に食い込んで新たな応力を発生させるのを防ぐことができ、ハニカム構造体の寿命延長効果を十分に確保することができる。また、請求項７記載のように、上記中央部を多角形状とし、この中央部の頂点の周方向位置に上記中間部及び外殻部の分割面の周方向位置を合致させることにより、請求項４記載のハニカム構造体と同様に、中央部の熱膨張の際にその頂点部分が径方向外側に突き出てもこの突き出た部分が外殻部に食い込んで新たな応力を発生させるのを防ぐことができ、ハニカム構造体の寿命延長効果を十分に確保することができる。

【図面の簡単な説明】

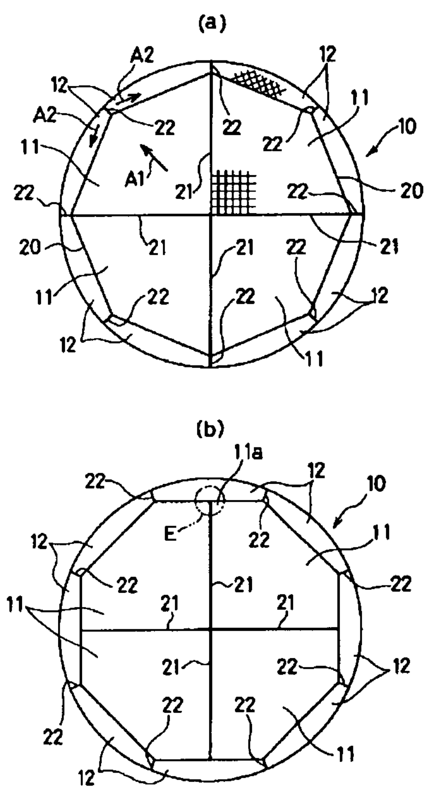
【図１】（ａ）は本発明の第１実施例におけるハニカム構造体の正面図、（ｂ）は同ハニカム構造体の変形例を示す正面図である。

【図２】上記ハニカム構造体が使用される触媒燃焼装置の断面側面図である。

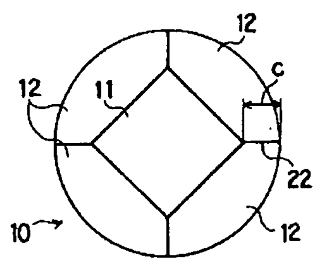
【図３】熱応力解析のモデルとなるハニカム構造体の構造を示す正面図である。

【図４】上記熱応力解析により得られた、外殻部分割面の長さ寸法と最大引張応力との関係を示すグラフである。
【図５】上記ハニカム構造体の変形例を示す正面図である。
【図６】本発明の第２実施例におけるハニカム構造体の正面図である。
【図７】本発明の第３実施例におけるハニカム構造体の正面図である。
【図８】本発明の第４実施例におけるハニカム構造体の正面図である。
【符号の説明】
8　筒状部材
＊１０　ハニカム構造体
１１　中央部セグメント
１２　外殻部セグメント
１３　中間部セグメント
１４　内側セグメント
１５　外側セグメント
２０　中央部と外殻部との分割面
２１　中央部の分割面
２２　外殻部の分割面
２３　中間部の分割面
２４　中間内側部の分割面
２５　中間外側部の分割面＊

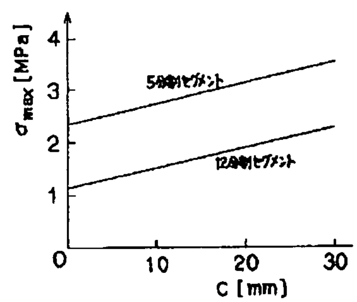
【図１】



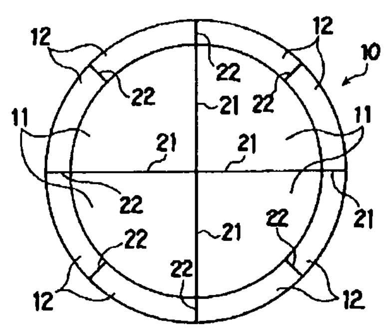
【図３】



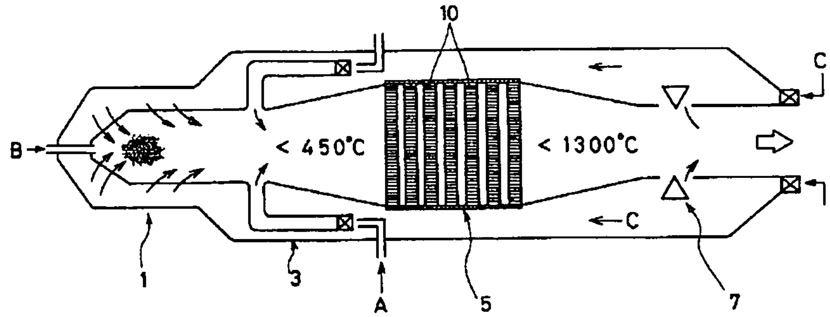
【図４】



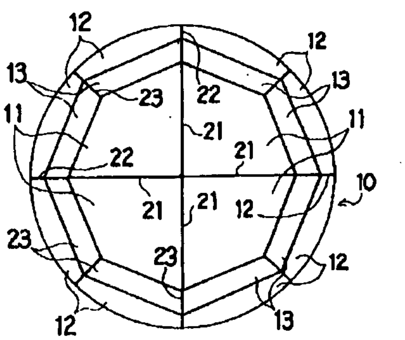
【図５】



【図2】


10
C
B
< 450°C
< 1300°C
C
1
3
A
5
7

【図6】


12
13
23
22
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12
10
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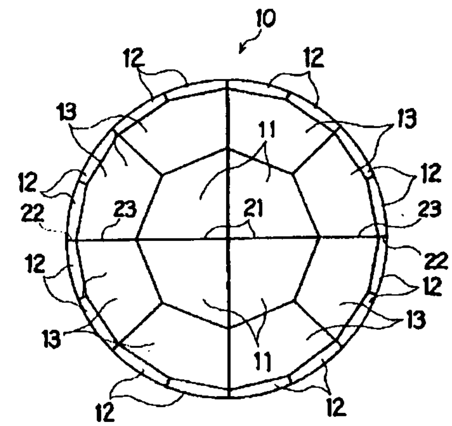
【図7】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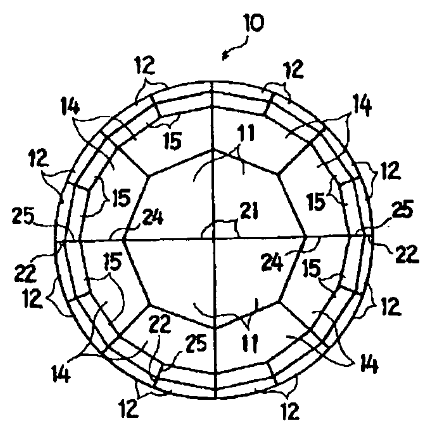
【図8】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